

CLAIMS

We claim:

- [c1] 1. An aircraft system comprising:
a wing;
an external structure positioned proximate to the wing; and
a unitary fitting attached to the wing and configured to transfer at least approximately all of the primary loads from the external structure to the wing, the primary loads including pitch loads and side loads, the unitary fitting including a first portion and a second portion, the first portion having at least a first attach feature and the second portion having at least a second attach feature spaced apart from the first attach feature, the first attach feature being configured to transfer at least a portion of the pitch loads from the external structure to the wing, and the second attach feature being configured to transfer at least a portion of the side loads from the external structure to the wing.
- [c2] 2. The aircraft system of claim 1 wherein the wing includes a front spar, and wherein the first and second portions of the unitary fitting are configured to be fixedly attached at least proximate to the front spar.
- [c3] 3. The aircraft system of claim 1 wherein the wing includes a front spar and a wing skin portion extending aft from the front spar, wherein the first portion of the unitary fitting is configured to be fixedly attached at least proximate to the front spar, and wherein the second portion of the unitary fitting is configured to be fixedly attached at least proximate to the wing skin portion.

- [c4] 4. The aircraft system of claim 1 wherein the first portion of the unitary fitting further includes a third attach feature spaced apart from the first attach feature and coupled to the external structure, the third attach feature configured to transfer at least a portion of the pitch loads from the external structure to the wing.
- [c5] 5. The aircraft system of claim 1 wherein the first portion of the unitary fitting further includes a third attach feature spaced apart from the first attach feature, wherein the first attach feature includes a first bore coupled to the external structure and the third attach feature includes a second bore coupled to the external structure, and wherein the second portion of the unitary fitting further includes a fourth attach feature spaced apart from the second attach feature, wherein the second attach feature includes a third bore coupled to the external structure and the fourth attach feature includes a fourth bore coupled to the external structure.
- [c6] 6. The aircraft system of claim 5 wherein the third and fourth bores are at least generally aligned along a common axis.
- [c7] 7. The aircraft system of claim 1 wherein the first portion of the unitary fitting further includes a third attach feature spaced apart from the first attach feature, wherein the first attach feature includes a first bore coupled to the external structure and the third attach feature includes a second bore coupled to the external structure, and wherein the second portion of the unitary fitting further includes a fourth attach feature spaced apart from the second attach feature, wherein the second attach feature includes a third bore coupled to the external structure and the fourth attach feature includes a fourth bore coupled to the external structure, further wherein the first, second, third and fourth bores are at least generally parallel.

- [c8] 8. The aircraft system of claim 1 wherein the external structure includes a propulsive engine.
- [c9] 9. The aircraft system of claim 1 wherein the external structure includes a turbo-fan engine.
- [c10] 10. The aircraft system of claim 1 wherein the external structure includes a fuel tank.
- [c11] 11. The aircraft system of claim 1 wherein the external structure includes a weapons system.
- [c12] 12. The aircraft system of claim 1 wherein the external structure includes a cargo hold.
- [c13] 13. The aircraft system of claim 1, further comprising a fuselage, wherein the wing extends outwardly from the fuselage.
- [c14] 14. An aircraft system comprising: ~
a wing having a front spar and a rear spar forming at least a portion of a wing box;
a jet engine positioned proximate to the wing; and
a unitary fitting attached at least proximate to the wing box and coupled to the jet engine, wherein the unitary fitting is configured to transfer at least approximately all of the flight loads from the jet engine to the wing box.
- [c15] 15. The aircraft system of claim 14, further comprising a nacelle positioned below the wing, wherein the jet engine is housed within the nacelle.

- [c16] 16. The aircraft system of claim 14 wherein the flight loads from the jet engine include pitch loads and side loads, and wherein the unitary fitting includes:
- a first portion having a first attach feature coupled to the jet engine, the first attach feature configured to transfer at least a portion of the pitch loads from the jet engine to the wing box; and
 - a second portion having a second attach feature spaced apart from the first attach feature and coupled to the jet engine, the second attach feature configured to transfer at least a portion of the side loads from the jet engine to the wing box.
- [c17] 17. The aircraft system of claim 14 wherein the unitary fitting includes:
- a first portion fixedly attached to the front spar, the first portion having at least a first attach feature coupled to the jet engine; and
 - a second portion extending aft of the front spar toward the rear spar, the second portion having at least a second attach feature spaced apart from the first attach feature and coupled to the jet engine.
- [c18] 18. The aircraft system of claim 14, further comprising an engine strut positioned below the wing and fixedly attached to the jet engine, wherein the engine strut has a forward portion and an aft portion, and the wherein the unitary fitting includes:
- a first portion having at least a first attach feature coupled to the forward portion of the engine strut; and
 - a second portion having at least a second attach feature spaced apart from the first attach feature and coupled to the aft portion of the engine strut.
- [c19] 19. The aircraft system of claim 14, further comprising an engine strut positioned below the wing and fixedly attached to the jet engine, wherein the

engine strut has a forward portion and an aft portion, and the wherein the unitary fitting is fixedly attached to the front spar and includes:

- a first portion having at least a first attach feature coupled to the forward portion of the engine strut; and
- a second portion having at least a second attach feature spaced apart from the first attach feature and coupled to the aft portion of the engine strut.

[c20] 20. The aircraft system of claim 14, further comprising an engine strut positioned below the wing and fixedly attached to the jet engine, wherein the engine strut has a forward portion and an aft portion, and the wherein the unitary fitting is fixedly attached to the front spar and includes:

- a first portion having a first attach feature spaced apart from a third attach feature, wherein the first and third attach features are coupled to the forward portion of the engine strut; and
- a second portion vertically offset from the first portion, the second portion having a second attach feature spaced apart from a fourth attach feature, wherein the second and fourth attach features are coupled to the aft portion of the engine strut.

[c21] 21. A fitting for attaching an external structure to a wing, the external structure transmitting primary loads in flight including pitch loads and side loads, the fitting including:

- a unitary body configured to transfer at least approximately all of the primary loads from the external structure to the wing, the unitary body having:
 - a first portion configured to be attached at least proximate to the wing, the first portion having a first attach feature configured to be coupled to the external structure and transfer at least a

portion of the pitch loads from the external structure to the wing; and

a second portion having a second attach feature spaced apart from the first attach feature and configured to be coupled to the external structure, the second attach feature configured to transfer at least a portion of the side loads from the external structure to the wing.

[c22] 22. The fitting of claim 21 wherein the wing includes a front spar, a rear spar, and a wing skin portion extending between the front spar and the rear spar, and wherein the first portion of the fitting is configured to be attached to the front spar and the second portion of the fitting is configured to be at least partially attached to the wing skin portion.

[c23] 23. The fitting of claim 21 wherein the unitary body is formed from a single piece of metal.

[c24] 24. The fitting of claim 21 wherein the unitary body is formed by fixedly attaching a first body portion to at least a second body portion.

[c25] 25. The fitting of claim 21 wherein the first portion of the unitary body further includes a third attach feature configured to be coupled to the external structure, and the second portion of the unitary body further includes a fourth attach feature configured to be coupled to the external structure, wherein the first attach feature includes a first bore and the third attach feature includes a second bore spaced apart from the first bore, the first and second bores being at least generally parallel, and wherein the second attach feature includes a third bore and the fourth attach feature includes a fourth bore spaced apart from the third bore, the third and fourth bores being at least generally parallel.

[c26] 26. The fitting of claim 21 wherein the unitary body includes at least one crack inhibiting mechanism positioned adjacent to at least one of the first and second attach features, wherein the crack inhibiting mechanism is configured to arrest crack propagation from proximate to one of the first and second attach features to proximate the other one of the first and second attach features.

[c27] 27. A method for attaching a propulsive engine to an aircraft wing, the propulsive engine transmitting primary loads in flight, the method comprising:
attaching a unitary fitting to the aircraft wing, the unitary fitting configured to carry at least approximately all of the primary loads transmitted by the engine in flight;
coupling the engine to a first portion of the unitary fitting; and
coupling the engine to a second portion of the unitary fitting, the second portion of the unitary fitting being spaced apart from the first portion.

[c28] 28. The method of claim 27, further comprising attaching the engine to an engine support structure, wherein coupling the engine to the first and second portions of the unitary fitting includes coupling the engine support structure to the first and second portions of the unitary fitting.

[c29] 29. The method of claim 28, further comprising, before attaching the unitary fitting to the aircraft wing:
forming at least a first bore in the first portion of the unitary fitting; and
forming at least a second bore in the second portion of the unitary fitting, wherein coupling the engine support structure to the first portion of the unitary fitting includes inserting a first pin in the first bore, and wherein coupling the engine support structure to the second portion of the unitary fitting includes inserting a second pin in the second bore.

[c30] 30. The method of claim 28 wherein coupling the engine support structure to the first and second portions of the unitary fitting includes coupling the engine support structure to the unitary fitting in the absence of coupling the engine support strut to any other fitting configured to carry the primary loads transmitted by the engine in flight.

[c31] 31. A system for attaching a propulsive engine to an aircraft wing, the propulsive engine transmitting primary loads in flight, the system comprising:
unitary means for transferring at least approximately all of the primary loads from the engine to the aircraft wing in flight;
means for structurally coupling the engine to a first portion of the unitary means; and
means for structurally coupling the engine to a second portion of the unitary means spaced apart from the first portion.

[c32] 32. The system of claim 31, further comprising strut means for supporting the engine offset from the aircraft wing, wherein the means for structurally coupling the engine to the first portion of the unitary means includes means for structurally coupling the strut means to the first portion, and wherein the means for structurally coupling the engine to the second portion of the unitary means includes means for structurally coupling the strut means to the second portion.